WRIA 9
TECHNICAL
COMMITTEE

2001
PROGRESS REPORT

CHAPTER 1. WRIA 9 TECHNICAL COMMITTEE 2001 PROGRESS REPORT

Upon completion of the WRIA 9 Factors of Decline Reconnaissance Report in December of 2000 a new technical committee was formed to lay the scientific foundation of the WRIA 9 Conservation Plan. This committee, the Technical Committee, first met on May 10th 2001 and began the task of strategically filling data gaps and establishing watershed-wide salmonid recovery goals based on science. The effort is known as the Strategic Assessment and a final report is due in 2003.

This progress report documents the achievements of this multi-jurisdictional science team during its first partial year of work in 2001. The achievements are placed into three categories:

- Technical Committee Formation
  Potential members were contacted and co-chairs selected to create a solid, multi-disciplinary team of scientists who dedicate several days per month to the Strategic Assessment. The team represents over 100 years of combined professional scientific experience and education. All of the members have worked within WRIA 9 and bring direct experience to the table. Members' biographies are contained in this report.

- Strategy Revision
  One of the first tasks was to revisit a watershed recovery strategy document developed in 2000 by the now defunct Factors of Decline Committee. New information was used to update the strategy but many of the major concepts remained. The latest version is included in this report and is expected to guide a variety of salmon recovery efforts in WRIA 9. The Technical Committee will continue to update this strategy throughout the Strategic Assessment.

- Research and Monitoring Agenda
  Through the examination of information data gaps identified by reconnaissance reports, the Technical Committee proposed and prioritized a list of research and monitoring projects. These projects will provide information necessary to focus the Strategic Assessment and promote science-based salmon recovery efforts in the watershed. Several of the top priority projects received funding through King County Conservation District. The complete list of projects identified during 2001 is contained in this report. A main future task of the committee will be to manage these projects and disclose their findings.

The Technical Committee intends to continue reporting progress on a yearly basis. The 2002 version is expected to contain a more detailed strategy and information on the initiation of several key research and monitoring projects.

WRIA 9 Technical Committee
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WRIA 9 Technical Committee Members

Karen Bergeron is a Hydrologist for the U.S. Forest Service at the Mt. Baker-Snoqualmie National Forest. She has been involved with interagency coordination involving land management activities, water quality and fisheries for the past 12 years. Specific projects include timber sale and road planning, aquatic inventories, and watershed restoration. She is in the graduate program at the University of Washington at the College of Forest Resources in Forest Soils and her research is focused on techniques of watershed restoration. She has a B.S. in Soil and Water Science from the University of California, Davis.

Eric Bixler is the Associate Watershed ESA Coordinator for WRIA 8 & 9 within Seattle Public Utilities for the City of Seattle. His involvement has been with endangered species within multiple states and a range of aquatic and terrestrial species with regards to freshwater habitat restoration. Nutrient and food web chains with relation to fish and restoration has been the main focus. He has a B.S. in Limnology from the University of Central Florida.

Jim Brennan graduated with a Master of Sciences in Marine Sciences Degree from Moss Landing Marine Laboratories, California State University, CA. Nineteen years of experience working in research, education, regulatory, environmental review, and watershed planning. While working as a research associate at MLML, participated in fisheries research programs in Antarctica, California, Oregon, Washington, and Alaska. Teaching experience includes fish biology, marine ecology, desert ecology, and tropical marine biology at various institutions and locations including U.C. Santa Cruz and MLML in California, and field studies programs in Jamaica and Baja California, Mexico. Other experience includes environmental consulting; Project Leader, marine mammal observer program, lower Columbia R.; Habitat manager, west Puget Sound; Senior Ecologist, King County watershed and salmon recovery planning.
Member: Estuarine Research Federation, Pacific Estuarine Research Society, American Fisheries Society. Current research interests include Puget Sound nearshore ecosystem characterization and assessment, salmonid factors of decline.

Terry Butler is an Earth Scientist in the King County Water and Land Resources Division, Rivers Section. In this capacity, Mr. Butler is completing a study of gravel accumulation and its effects on flooding in parts of the Snoqualmie River basin. Mr. Butler also is involved in the study of channel migration and worked with King County DDES to prepare a land use regulation that restricts development in channel migration areas. In a previous position with King County, Mr. Butler was a Green River Engineer. Primary job duties were to develop a draft flood plan and participate in an aquatic restoration plan for the Mill Creek (Auburn) basin, act as County liaison to the Army Corps of Engineers on flooding and dam operation issues, and design and construct a few bank stabilization projects. The majority of Mr. Butler's work experience is in water resource management at the County level, with work at a previous job on watershed management, water supply planning, flood response and recovery, erosion control

projects, and participation in various technical committees. Mr. Butler has a BA in Biology and Environmental Studies from UC Santa Cruz, a year of non-matriculated study of geology at UCSC, and an MSE in Environmental Engineering and Science with focus on Water Resources from University of Washington. Mr. Butler is a Professional Engineer.

Fred Goetz - M.S. Fisheries Science Oregon State; B.S. Michigan State Environmental Studies 12 years fisheries experience with Federal Government, USFS and Corps. Regional or National Expert in bull trout, conducted research in sampling protocol, habitat use: on bull trout recovery team. Restoration specialist, fish passage, instream structures. Reservoir management and instream flow 8 years experience.

Paul Hickey is Assistant Water Resource Planning Coordinator for Tacoma Public Utilities, Water Division. He has a B.A. degree in Psychology from St. Martin's College in Lacey, Washington, and a M.Sc. degree in Fisheries Biology from the University of Washington. His graduate research focused on salmonid genetics. He is a Certified Fisheries Scientist of the American Fisheries Society with 23 years experience in the fisheries and water resource planning fields, and is also a member of the American Water Resources Association and Society for Ecological Restoration. In addition to his work for Tacoma Water, he has been employed by the Guatemalan Ministry of Agriculture as a Peace Corps Volunteer, and as a biologist for AquaSea Farms (a salmon aquaculture company), the Washington Department of Fisheries, the Muckleshoot Indian Tribe, and Tacoma Power. For the past 15 years, his work has focused on the mitigation and restoration of riverine and terrestrial ecosystems impacted by dam operations.

Jon Houghton, Ph.D., is a senior biologist with over 31 years of research and consulting experience in baseline studies, ecological risk assessment, permitting, habitat restoration, and ESA response planning and involved substantial field research in marine, estuarine, and freshwater environments. He has special expertise in the nearshore ecology of Washington and Alaska and in coastal habitat evaluation and restoration. His Puget Sound marine experience has included evaluations of benthic infauna and epibenthic zooplankton populations and surveys of use of nearshore areas by demersal fish and invertebrates in Port Gardner. He has also directed dozens of eelgrass surveys and three successful eelgrass transplantings. His estuarine work experience in the area has included beach seining programs to evaluate juvenile salmonid timing and abundance. He also directed a yearlong study of juvenile salmonids in the Snohomish River estuary; this study used beach seines, fyke nets, and epibenthic sampling to explore salmonid and other taxa use of tidal marshes and river channels. He has an A.B. in Biology, *cum laude* from Harvard University and a Ph.D. from the College of Fisheries, University of Washington.

Kirk A Lakey, PWS, is a Fish and Wildlife Biologist for the Washington Department of Fish and Wildlife, Habitat Division. Mr. Lakey is the Watershed Stewardship Team member assigned to provide technical assistance to the Lead Entities (LE) in the Green-Duwamish Water Resource Inventory Area (WRIA) 9, Cedar-Lake Washington WRIA 8, as well as the Mid-Puget Sound Fisheries Enhancement Group (MPSFEG) and the Stilly

–Snohomish Fisheries Enhancement Task Force (SSFETF). Mr. Lakey has been working through out the United States and overseas as a professional in the natural resource field for over 15 years. His past work experience includes the characterization, assessment, and delineation of wetlands as well as the development of mitigation plans for the creation, restoration and enhancement of wetland systems. He is also experience in terrestrial habitat analysis and evaluations, threatened and endangered species surveys, and interpreting, international, federal, state and local regulations and policies. Mr. Lakey is a Professional Wetland Scientist (PWS) with a Bachelor of Science in Range Management and Wildlife Habitat Management from Washington State University.

Tom Nelson has 19 years experience as a Fisheries Biologist after receiving a BS in Fisheries from University of Washington. He worked for a variety of governmental agencies (National Marine Fisheries Service, California Fish and Wildlife, Washington Department of Fisheries, King County) on marine and freshwater projects, primarily involving salmon and their habitat. He served 3 years as a State freshwater harvest management biologist monitoring and estimating/projecting wild salmonid runs on the Olympic Peninsula. This included supervision of redd survey, smolt trapping/tagging, juvenile seining and electrofishing crews. He spent 5 years as a State Regional Habitat Manager which implemented the State Hydraulic Code by assessing various freshwater and marine project impacts on salmon habitat. Wrote permits for habitat protection and checked for compliance. For the past 9 years, he has worked at King County working primarily on salmon habitat projects, including designing, permitting, implementing and overall project management of stream and marine habitat restoration/mitigation projects. During the past two years, he has been involved with the WRIA 9 planning process providing technical assistance and acting as the co-chair of the Factors of Decline technical committee.

Lorin Reinelt, Ph.D., is a Senior Water Quality Scientist for the King County Water and Land Resources Division. He is project manager of the Green-Duwamish Water Quality Assessment and actively involved in the WRIA 9 salmon conservation planning efforts. He has been involved in public service, research, education, and consulting on water resources issues for the past 17 years. This includes nonpoint source pollution management in urban and agricultural areas, water quality assessment, wetlands and stormwater management, basin planning, aquatic resource monitoring, stream rehabilitation and habitat enhancement, flood hazard mitigation, and groundwater management. His research and graduate studies focused on aquatic resource monitoring, watershed modeling, water quality treatment, and science and environmental policy. He has a B.S. in Civil Engineering from the University of the Pacific, M.S. in Environmental Engineering and Science from the University of Washington, and a Ph.D. in Water and Environmental Studies from Linkoping University in Sweden. He is a registered professional wetland scientist and engineer-in-training.

Kathy Taylor, Ph.D., is a Local Environmental Liaison for the Puget Sound Water Quality Action Team in the Office of the Governor of the State of Washington. She assists local governments in King and Pierce counties in implementing the Puget Sound

Water Quality Management Plan. She has been involved in public service, research, education, and environmental stewardship for the past 15 years. She has conducted research and published papers in peer-reviewed journals on the interactive effects of multiple stressors on wetland plant communities along a salinity gradient, the effects of fire on several different plant communities, and the effects of mammal herbivory in marshes, as well as several other topics. As an Assistant Professor of Biology at Coastal Carolina University (in South Carolina), she taught university classes in wetland plant ecology, plant-animal interactions, principles of ecology, principles of biology, and scientific writing, as well as publishing papers in peer reviewed education journals. As Executive Director of the Columbia River Estuary Study Taskforce, a Council of Governments (cities, counties, and ports) in Washington and Oregon, surrounding the Columbia River Estuary, she directed many information-gathering, environmental policy, and community stewardship projects focused of the Columbia River Estuary. She has a B.S. in Biology from Western Washington University, M.S. in Biology (Plant Ecology), also from Western Washington University, and a Ph.D. in Wetland Plant Ecology (through the Department of Botany) from Louisiana State University.

Jim Starkes is a Fisheries Biologist and Project Manager for Pentec Environmental. He has over 14 years of experience evaluating the effects of anthropogenic activities on anadromous fish and their habitats. Since the listing of Puget Sound chinook salmon and bull trout, Jim has been deeply involved with ESA issues in Puget Sound including research, ESA program development, and regulatory permitting and compliance. He is presently managing two bull trout monitoring programs in central Puget Sound, one of which is a radio-tagging study to electronically monitor the movements of anadromous bull trout in tidal freshwater and marine environments. He manages a juvenile salmon monitoring program in south Puget Sound as part of a Biological Opinion issued by NMFS to determine the migratory timing and potential exposure of juvenile chinook salmon to dioxin contaminated sediments. Jim co-authored the State of the Nearshore Report, a compilation and assessment of existing literature and data on the anthropogenic impacts of nearshore environments in WRIAs 8 and 9. He is also a project manager on the environmental team assisting the City of Tacoma in the environmental cleanup and redevelopment of the City's waterfront along the Thea Foss Waterway of Commencement Bay. Jim has a B.S. in Fisheries Biology from the University of Washington.

Initial Strategy for Multi-Species Salmonid ~~Conservation and Recovery in the Green/Duwamish and~~ Central Puget Sound Watersheds

(Water Resource Inventory Area 9 and Vashon/Maury Islands)

Protect, Connect and Unlock the Natural Potential

June 2001

SUMMARY

The Water Resource Inventory Area (WRIA) 9 Technical Committee developed this strategy to help prioritize initial actions for salmonid conservation and recovery in the Green/Duwamish River watershed and nearshore areas of WRIA 9, including Vashon/Maury Islands. The strategy is based on the current state of knowledge of existing conditions and the ecological principles and habitat limiting factors described in the Habitat Limiting Factors and Reconnaissance Assessment Report (2000). It builds upon the initial strategy developed by the Factor of Decline Subcommittee (FODS). The strategy is designed to help focus future actions in the WRIA 9 watershed such as research and studies, habitat preservation, and restoration, rehabilitation and enhancement efforts. This document contains five sections: (1) principles to guide salmon recovery, (2) habitat factors of decline, (3) the initial WRIA 9 strategy, (4) subwatershed actions and priorities, and (5) use of the initial strategy in the WRIA 9 planning process.

The WRIA 9 strategy identifies three high-priority watershed goals to address habitat issues in support of salmon conservation and recovery:

- **Protect currently functioning habitat** (primarily in the Middle Green River Subwatershed and the nearshore areas of Vashon/Maury Islands)

- **Ensure adequate juvenile salmonid survival** in the Lower Green River, Duwamish River and Nearshore subwatersheds

- **Restore access for salmonids** (efficient and safe passage for adults and juveniles) to and from the Upper Green River Subwatershed

The initial strategy for multi-species salmon conservation and recovery will be used for three purposes: (1) to support development of the Near-term Action Agenda, (2) to evaluate and prioritize projects (e.g., for SRF Board and KCD funding), and (3) to support development of a research agenda for the strategic assessment.

PRINCIPLES TO GUIDE SALMON RECOVERY

The National Marine Fisheries Service (NMFS), in its guidance for comprehensive salmon conservation and recovery habitat plans, identified five objectives as central to salmon conservation efforts (NMFS, 1996; Spence et al., 1996). The FODS group used this guidance and other documents to develop a list of principles as a basis for developing the proposed strategy for WRIA 9. These principles are:

- Protect and maintain existing physical, chemical, and biological processes and the habitats they form as well as restoring those that have been degraded or lost. This includes five sub-principles:

- Protect and restore the natural ecosystem processes responsible for creating habitats required by salmonids;
- Protect and restore those habitats that are necessary during all life stages of salmonid development;
- Maintain quality habitats that function as refugia ("fish sanctuaries") from which salmonid populations may expand;
- Maintain the corridors (connectivity) that link habitats and emphasize the (re)connection of freshwater, estuarine, and saltwater habitats and their associated zones as required by salmonids during all life stages; and
- Adopt an ecological approach to maintaining, improving, and restoring freshwater, estuarine, and saltwater habitats and their associated zones.

- Emphasize self-sustaining runs of naturally-spawning salmon when developing protection and restoration strategies.
- Preserve protection and restoration/rehabilitation opportunities for critical habitats.
- Apply scientifically rigorous adaptive management techniques to all elements of recovery activities for WRIA 9.

HABITAT FACTORS OF DECLINE

WRIA 9 currently produces chinook, steelhead, coho, chum, cutthroat and some sockeye and pink salmon. However, habitat that supports this production must be maximized for the watershed to reach its potential. Habitat has declined severely in the Lower Green, Duwamish, and Nearshore subwatersheds since the early 1900s. In the Upper and Middle Green subwatersheds, the dams have blocked upstream and downstream passage of salmonids, interrupted gravel transport, and altered flow regimes. Some of the primary habitat factors of decline for each subwatershed and the salmonid species present are listed below:

UPPER GREEN RIVER SUBWATERSHED (ABOVE RIVER MILE 64.5):

Factors of decline

The Howard Hanson Dam is a complete upstream barrier that prevents anadromous salmonids from migrating to and from the Upper Green River Subwatershed. A key component to realizing the recovery potential of the watershed will be efficient passage at the dam for both adults and juveniles. Logging, revetments, roads with associated runoff and barriers, reservoir inundation, and water withdrawal also potentially affect salmonids in the Upper Green Subwatershed.

Current salmonid use

Resident cutthroat, rainbow, and brook trout, as well as planted steelhead, chinook, and coho utilize the Upper Green Subwatershed. Bull trout have not been documented.

MIDDLE GREEN RIVER SUBWATERSHED (RIVER MILE 64.5. TO 32.0):

Mainstem factors of decline

The Tacoma diversion dam, revetments, and residential and agricultural land use have resulted in water withdrawals, changes in the natural flow regime, sediment starvation and scouring, loss of side channel and other off-channel habitats, disconnection of mainstem flows from the floodplain, and loss of riparian habitat functions.

Current mainstem salmonid use

Spawning and rearing of chinook, steelhead, coho, chum, as well as some pink and sockeye salmon. All species (including cutthroat and bull trout) use this subwatershed for migration and feeding.

Tributary factors of decline

Residential, agriculture and some urban development resulting in: (1) wetland and riparian function removal and increasing impervious surfaces leading to hydrologic disruption to stream flow, channel degradation, and degraded water quality; (2) rechanneling of streams and limiting their lateral migration to facilitate roads and protect property; (3) removal of in-channel woody debris; and (4) barriers to migration. There are also some tributaries where salmonid access is limited, or that are disconnected from the mainstem.

Current tributary salmonid use

Mostly coho and cutthroat, some chinook, steelhead, and chum, and a few sockeye.

LOWER GREEN RIVER SUBWATERSHED (RIVER MILE 32.0 TO 11.0):

Mainstem factors of decline

Factors of decline include: (1) urbanization; (2) the historic diversion of the White River and Cedar River from the Green/Duwamish River; (3) dam flow manipulation, and revetments resulting in lowering of the main channel and disconnection of off-channel habitats such as sloughs, adjacent wetlands, and floodplains; (4) reduction of instream complexity (wood), pools and riffles; (5) barriers from flood control gates; (6) degraded water quality conditions; and (7) severely reduced riparian functions.

Current mainstem salmonid use

Upstream and downstream migration and rearing for all species, some chinook salmon and steelhead spawning.

Tributary factors of decline

Urbanization and other human activities have resulted in: (1) loss of forest cover and increased impervious surfaces leading to unstable streambed channels and disruption of natural flow regimes; (2) roads with associated runoff and barriers; (3) water quality degradation; (4) loss of riparian function; (5) stream channelization to facilitate efficient agriculture and urbanization; and (6) invasion by non-native plants and aquatic species. Some tributaries have difficult salmonid access or are disconnected from the mainstem.

Current tributary salmonid use

Many tributaries can no longer maintain self-sustaining runs, although some coho and cutthroat still use select tributaries. Some of the tributaries, especially near their confluence with the mainstem, may provide important rearing habitat for juvenile salmonids born in other areas of the watershed.

DUWAMISH SUBWATERSHED (11.0 TO 0.0):

Mainstem factors of decline

Urbanization/industrialization has resulted in (1) dredging/channelization and filling of at least 97 percent of the estuarine mudflats, marshes, and forested riparian swamps;

(2) elongation and simplification of remnant channels by dredging and shoreline armoring; and, (3) water quality degradation by industrial activities, and stormwater and wastewater discharges.

Current mainstem salmonid use

All species migrate, rear, and acclimate in this transitional area between river and marine waters. Salmonids born outside the watershed also use the Duwamish estuary for rearing. Juvenile chinook, chum, and pink salmon are most dependent on the estuary. Some char sub-adults and adults have also been consistently documented in this reach.

Tributary factors of decline

Intensive development has made many tributaries inaccessible and inhospitable for salmonids. Most of the small patches of remaining marginal habitat are disconnected from the mainstem and heavily impacted by stormwater flows and degraded water quality. Functional riparian areas have been eliminated or fragmented to a few undeveloped areas.

Current tributary salmonid use

Some cutthroat and coho are observed in a few streams, but most are incapable of producing a self-sustaining run. The lower end of tributaries may provide important rearing habitat for juveniles born in other areas of the watershed.

NEARSHORE SUBWATERSHED

Factors of decline

Much of the WRIA 9 marine shoreline has been filled, hardened, and/or replaced with bulkheads, and altered as a result of land use practices. Extensive areas in major waterways have been dredged to maintain navigation. The supply of beach sediment has been curtailed and water quality impacts stemming from upland areas may be affecting nearshore habitats. Riparian vegetation is lacking as a result of urbanization. Riparian functions that contribute to the nearshore ecosystem are greatly reduced. In short, shorelands and intertidal areas and the processes that maintain them have been significantly altered, thus reducing properly functioning conditions that support salmonids. Most nearshore tributary streams have been channelized, riparian zones degraded, hydrology dramatically modified, and outlets often have barriers.

Current salmonid use

Many species of juvenile salmonids, such as chinook, chum, and pink salmon, are dependent on the nearshore for physiological transition, migration, and rearing prior to their rigorous ocean migration. The nearshore also produces important food items for all life stages of salmonids. Especially important are the forage fish for salmonids (e.g., sand lance, surf smelt, and herring), which require specific habitat conditions in this area for reproduction and rearing.

THE STRATEGY – PROTECT, CONNECT AND UNLOCK THE NATURAL POTENTIAL

A component of any successful ecologically based restoration strategy is to protect and maintain watershed habitat forming processes that are functioning properly. Specifically, NMFS (1996) states in its guidance for salmon conservation that "spawning and rearing areas that consistently yield the highest concentrations of fish should be identified as a high priority for protection." Following this guidance, one goal of the WRIA 9 strategy for salmon recovery is to protect

currently functioning productive habitat, which is primarily concentrated in the Middle Green River Subwatershed and the nearshore areas of Vashon/Maury Islands.

A second important goal is to ensure adequate juvenile salmonid survival in the Lower Green River, Duwamish River, and Nearshore subwatersheds. It is important that habitat in these subwatersheds provide the essential ecological functions necessary to support watershed-wide salmon conservation efforts. Since large data gaps regarding carrying capacity, habitat use and survival occur in these lower subwatersheds, scientific studies should be designed and carried out to fill these gaps and direct habitat conservation activities. Reasonable, scientifically defendable opportunities for increasing habitat in these lower reaches should be explored in concurrence with ongoing research. Another initial goal will be to restore salmonid access to productive habitats. The major focus will be on the Upper Green River Subwatershed. However, many migration barriers also exist on tributaries and access to historic mainstem side channels is also a concern. These three goals are not prioritized but must work together and be adapted to specific situations and opportunities within the watershed.

- **Protect currently functioning habitat** (primarily in the Middle Green River Subwatershed and the nearshore areas of Vashon/Maury Islands)

This includes:

  - Preserving physical habitat (e.g., spawning habitat, eelgrass beds), natural ecosystem processes (e.g., gravel and large woody debris recruitment, longshore transport of sediment), refugia (off-channel ponds, backwater sloughs), riparian vegetation, and nearshore areas with high salmonid use;
  - Managing flows to maximize salmonid habitat in mainstem reaches of the Green River;
  - Protecting water quality conditions that currently support salmonids, such as streams and groundwater inputs that provide cold, clean water;
  - Protecting habitat connectivity that links freshwater, estuarine and saltwater habitats as required by salmonids during all life stages; and
  - Managing landscape and watershed-wide land use changes to minimize adverse impacts on aquatic habitat.

Areas that are currently providing critical functions should be identified and targeted for protection. The Metzler-O'Grady reach (about River Mile 38 to 40) of the Middle Green River Subwatershed is a good example of important habitat that is currently supporting naturally spawning chinook, steelhead, chum, some coho and a few sockeye and pink salmon.

- **Ensure adequate juvenile salmonid survival** in the Lower Green River, Duwamish River, and Nearshore subwatersheds

The severely degraded lower subwatersheds must provide essential ecological functions for salmonids to survive. This includes protecting existing functioning habitat, restoring degraded habitat, and maintaining adequate water quality and flows. It will be critical to preserve opportunities for future habitat restoration in the Lower Green, Duwamish, and Nearshore subwatersheds. Success in realizing the potential of salmonid recovery in WRIA 9 will depend on the availability of adequate habitats downstream for rearing and migration. Juveniles from the Upper and Middle Green subwatersheds require the nurturing of the Lower Green, Duwamish, and Nearshore subwatersheds to survive.

The downstream and nearshore areas of WRIA 9 are characterized by a high degree of habitat loss and damage and have been heavily altered by human activities. Among the most significant are the filling of 97 percent of the Duwamish River's historic floodplain marshes and intertidal mudflats, and the extensive urban development of upland areas. The severely modified conditions of the Lower Green, Duwamish, and Nearshore subwatersheds will make restoration a challenge. It will be necessary to direct rehabilitation efforts through modeling, scientific research, and properly designed monitoring and assessment methods. These areas will be costly to rehabilitate and it will take time to determine how well they respond. Nonetheless, actions are necessary to identify and improve critical habitat functions (that provide for optimal migration, rearing, and osmoregulatory adjustment) for the survival of salmonids produced in upstream refugia and other areas, and for the production and survival of prey. Water quality conditions and flow regimes must be compatible with salmonid life-cycle needs.

There is a lack of detailed information concerning basic salmonid habitat utilization and survival requirements in the Lower Green, Duwamish, and Nearshore subwatersheds. Consequently, initial investigations should be directed at understanding and addressing the limitations these areas have on supporting salmonid juveniles, with specific focus on potential "bottlenecks" (areas that are currently limiting). Habitat restoration projects should be managed through scientific design, monitoring and making adaptive changes when necessary. Juvenile salmonid survival studies should be initiated in these subwatersheds to link production prospects with the rest of the watershed. Results of these studies will also help in the design of restoration efforts and reduce the risk that more fish produced upstream will encounter capacity bottlenecks downstream. These efforts will particularly benefit chinook and chum, whose life cycle needs rely heavily on estuarine and nearshore habitats.

- Restore access for salmonids to and from the Upper Green River Subwatershed

This includes providing efficient and safe passage for adults and juveniles around the dams and operating the Howard Hanson Dam to minimize impacts on salmonids. This could dramatically increase the number of naturally produced juvenile salmonids in the watershed. The two mainstem dams are complete barriers to the natural upstream migration of anadromous salmonids to the Upper Green River Subwatershed. HHD is also nearly a complete barrier to downstream migration of juvenile salmonids. Efficient upstream and downstream passage will dramatically increase available spawning and rearing habitat, especially for chinook, coho, steelhead and cutthroat, and possibly result in an equal response in juvenile production.

The Upper Green River Subwatershed (River Mile 93.0 to 64.5) may hold the greatest potential for increasing natural salmonid production in the freshwater portion of the watershed. Dams have blocked fish access to approximately 106 lineal stream miles and half of the Green-Duwamish River watershed acreage. The Upper Subwatershed contains many reaches of suitable spawning and rearing habitat for salmonids, and has the potential to become important refugia if access is restored.

This reach has been adversely affected by logging, a dam, roads, a railroad, and reservoir flooding; however, because of the limited extent of land use practices and distance from population centers, many of the basic habitat forming processes such as sediment transport and flow regimes remain intact. This subwatershed is also large enough to provide salmonid refugia (Frissel, 1997) that can seed the degraded downstream habitat once efficient passage is provided around the dams. This is particularly important since the lower subwatersheds may no longer have the capacity to naturally rebound from disturbance events.

SUBWATERSHED ACTIONS AND PRIORITIES

Actions and priorities for each subwatershed vary because of the differences in the quality and quantity of existing habitats, the relative importance of the habitat functions provided, and the state of our knowledge and data gaps.

The following set of conservation and recovery actions should not be considered a complete suite but instead emphasize the primary approaches for each area based on the Habitat Limiting Factors and Reconnaissance Assessment Report (2000). A more complete assessment of habitats and ecological processes will occur in the years ahead through the Strategic Assessment. This information will then be assembled to provide the technical and scientific basis of the long-term, comprehensive salmonid recovery plan for WRIA 9.

UPPER GREEN RIVER SUBWATERSHED:

- **Protect** critical habitats and habitat forming processes responsible for the natural production of salmonids.
- **Connect -** restore safe and efficient upstream and downstream passage for adult and juvenile salmonids at the Howard Hanson Dam. Restore access from the Upper Green River mainstem to tributaries.
- **Rehabilitate/Enhance** habitat along the mainstem river and tributaries. Operate Howard Hanson Dam in such a manner as to reduce impacts of flow alterations on sediment transport, available habitat and water quality downstream. Rehabilitation efforts should be based on ecosystem principles and managed adaptively.
- **Fill data gaps** such as baseline habitat quantity and quality, outmigration of juvenile salmonids, including effects of reservoir storage and flow impacts on juvenile fish in the mainstem and North Fork Green River, and impacts of land use practices on habitat in the Upper Green River Subwatershed.

MIDDLE GREEN RIVER SUBWATERSHED:

- **Protect** critical habitats and habitat forming processes responsible for the natural production of salmonids. Protect spawning and rearing areas that consistently yield the highest concentrations of salmonids on the mainstem and tributaries.
- **Connect** mainstem channel and flows with side-channels and floodplain habitat, and restore access to and within tributaries for salmonids. Restore safe and efficient upstream and downstream passage for adult and juvenile salmonids at the Tacoma diversion dam.
- **Rehabilitate/Enhance** critical interrupted processes including LWD input, flow regimes, and gravel transport. Enhance aquatic habitat within the mainstem and tributaries. Rehabilitation efforts should be based on ecosystem principles and managed adaptively.
- **Fill data gaps** such as how flow releases impact fish stranding and redd success, and salmonid survival studies focused on behavior, growth, survival rates and needs, and habitat carrying capacity. Evaluate options for gravel and LWD supplementation.

LOWER GREEN RIVER SUBWATERSHED:

- **Protect** areas that currently provide critical habitat or have reasonable potential for improvement to keep rehabilitation options open while data gaps are being addressed.
- **Connect** mainstem channel and flows with side-channels and floodplain habitat, and restore access to and within tributaries for adult and juvenile salmonids.

- **Rehabilitate/Enhance** aquatic habitat and water quality within the mainstem and tributaries. Rehabilitation efforts should be based on ecosystem principles and managed adaptively.
- **Fill data gaps** through salmonid survival studies of behavior, growth, survival rates and needs, and habitat carrying capacity. Study results should lead to improved rehabilitation designs, clearer priorities for protection and acquisition, and an understanding of the natural production capability of the watershed. Rehabilitation efforts should be based on ecosystem principles and managed adaptively.

DUWAMISH RIVER SUBWATERSHED:

- **Protect** habitat that currently provides support for salmonids or has reasonable potential for enhancement to keep rehabilitation options open while data gaps are being addressed.
- **Connect** mainstem channel and flows with side-channels and floodplain habitat, and restore access to and within tributaries for adult and juvenile salmonids.
- **Rehabilitate/Enhance -** Increase habitat area by moving back banks, reducing slopes, and excavating filled areas to restore natural tidal circulation and productive habitat. Increase habitat quality by softening shoreline materials, increasing habitat complexity through the addition of LWD, establishing conditions for deposition of sediment and organic matter, and increasing areas of marsh and riparian vegetation. Rehabilitation efforts should be based on ecological principles and managed adaptively.
- **Fill data gaps** through salmonid survival studies of behavior, growth, survival rates and needs, and habitat carrying capacity. Study results should lead to better rehabilitation designs, clearer priorities for protection and acquisition and an understanding of natural production capability of the watershed.

WRIA 9 NEARSHORE AND VASHON/MAURY ISLANDS:

- **Protect** nearshore processes, structure and functions in riparian and aquatic areas that support salmonids. Unaltered areas are particularly important for protection and should be maintained, or enhanced, if appropriate, to provide nearshore functions and avoid future restoration actions.
- **Connect** upland areas to shorelines, shorelines to intertidal areas, and restore access to and within tributary streams.
- **Rehabilitate/Enhance** critically damaged processes, including sediment transport on a "process unit" basis (drift cells may be an appropriate surrogate in the nearshore environment). Restore linkages (connectivity) between high salmonid use areas (e.g., eelgrass beds, sub-estuaries) and other habitats utilized during the salmonid life cycle. Rehabilitation efforts should be based on ecosystem principles and managed adaptively.
- **Fill data gaps** through salmonid studies evaluating habitat preferences and/or utilization of nearshore environments such as eelgrass beds, sub-estuaries, and other habitat types. Initial studies should focus on listed species (chinook, bull trout). Furthermore, studies should focus on identifying high salmonid use areas that play important roles in support of salmonids and salmonid prey species. Evaluate how human activities and alterations (upland development, bulkheads/piers) modify salmonid habitat and affect utilization by salmonids. Study results should lead to improved rehabilitation designs, and clearer priorities for protection and acquisition. Rehabilitation efforts should be based on ecosystem principles and managed adaptively.

NEXT STEPS AND USE OF THE STRATEGY

The initial strategy for multi-species salmon conservation and recovery in WRIA 9 will be used to support the following three processes in the near-term (prior to completion of the long-term salmon conservation plan):

- Development of the Near-term Action Agenda (NTAA) – the NTAA will recommend policies, programs, and projects that will be based in part on the initial strategy.
- Evaluation and prioritization of projects for Salmon Recovery Funding Board and King Conservation District funding.
- Development of a research agenda for the strategic assessment (to be carried out over the next two years) based on the data gaps identified and priorities listed in the initial strategy.

REFERENCES

National Marine Fisheries Service. 1996. Coastal Salmon Conservation: Working Guidance for Comprehensive Salmon Restoration Initiatives on the Pacific Coast. Northwest and Southwest Regions.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitski. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvalis, OR.

Criteria for Evaluating Research and Monitoring Projects

Category	Questions	Possible Answers
1. Relevant?	(a) Does the proposal address an identified data gap?	Yes or No
	(b) Would the results address habitat restoration or conservation activities?	Yes or No
	(c) Does it apply to listed species?	High, Medium, or Low
	(d) Is it likely to inform decision-making?	High, Medium, or Low
	(e) What it its likelihood of success?	High, Medium, or Low
2. Urgent?	(a) Would the results support actions that stop harm to important habitat-forming processes?	High, Medium, or Low
	(b) If this project were not implemented, would we lose an opportunity to acquire information that leads to conservation actions?	High, Medium, or Low
3. Timely?	Will the study produce meaningful results that can be used to develop the 2004 salmon conservation plan?	High, Medium, or Low
4. Obsolete?	Will the study <u>not</u> become obsolete in the near future?	Yes or No
5. Leverage?	Are there opportunities to leverage other funds?	High, Medium, or Low
6. Cost-Effective?	Is the project cost-effective?	High, Medium, or Low

Point System:

- High = 2 points
- Medium = 1 point
- Low = 0 points
- Yes = 2 points
- No = 0 points

Total points available: 22

Ranking of Research and Monitoring Proposals

Summary Table:

Proposal	Identifier	Total Points
Inventory of Productive Fish Habitat	Protection Proposal #1	21
Development of a research framework for determining current bottlenecks that adversely affect juvenile salmonid survival.	Juvenile Salmonids Proposal #1	21
Nearshore Baseline Habitat Mapping[1]	Habitat Monitoring Proposal #4	20
Lower Green River Baseline Habitat Mapping	Habitat Monitoring Proposal #3	20
Gravel Source Areas in WRIA 9	Protection Proposal #4	20
Inventory of feeder bluffs and other beach feeding sources	Protection Proposal #6	20
Water Quality Sampling Site at RM 21	Habitat Monitoring Proposal #1	19
Identification and Characterization of Important Groundwater and Surface Water Inputs to the Middle Green Sub-basin	Protection Proposal #2	19
Assessment of Flow Management Alternatives in the Middle Green	Protection Proposal #5	19
WRIA 9 LWD Recruitment Assessment	Protection Proposal #3	18
The WRIA 9 Water Budget	Habitat Monitoring Proposal #2	17
Development of Sediment Budgets for WRIA 9 Drift Cells	Protection Proposal #6 (Phase II)	16
Inventory of Legality of Water Withdrawals from WRIA 9	PWG Proposal #6 (Phase II)	15
Identification of tributaries with the greatest habitat potential and assessment of fish passage barriers by jurisdiction	PWG Proposals #1 and #8 (combined)	14

[1] The Technical Committee ranked this proposal based upon the desired outcome, not the proposed method. The Committee agreed to hold further discussions about what methodology to use to map nearshore habitat.

Study Proposal (Unnumbered)
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Develop a research framework for determining current bottlenecks in the Green/Duwamish system which adversely affect juvenile salmonid survival.**

2. **Define the action.**
   There are several studies currently planned for the Lower Green/Duwamish/Nearshore area. We need to develop an overall approach to examining juvenile survival in these areas and then determine how to support each of the planned studies so that they contribute to answering the questions posed in the framework. This work could be done by a consultant or could be taken on by the technical committee.
   1. Develop an overall framework to approaching the question of juvenile Salmonid survival
   2. Looking at the existing and planned studies, determine how these studies could be connected to respond to the framework.
   3. Coordinate as needed with existing and planned studies to create a data collection system that will allow the analysis necessary to lead to answers about the possibility of bottlenecks in the Lower Green, Duwamish or nearshore.
   4. Design studies specific to filling any gaps not covered by the research of others
   5. If a bottleneck is identified, design further research to more clearly define what is causing the bottleneck.

3. **If the project can be phased, describe which elements would be in the first phase.**
   1. Develop the framework and coordinate with existing studies.
   2. Design new studies as needed
   3. Design studies to further refine the results of 1 and 2.

4. **What factor(s) of decline does the action most closely address/relate?** Possible factors include Habitat loss, loss of riparian vegetation, water quality

5. **State the direct link to salmon conservation.**
   If we can clarify where the current bottleneck is (assuming one exists in the Lower Green, Duwamish or nearshore) then we will better target actions likely to contribute to salmonid conservation.

6. **Describe benefit of project to salmon or to the overall conservation planning process (gain).**
   Increased juvenile survival may increase returns

7. **Describe implementation challenges including public and political acceptance or resistance (pain).**
   Developing the framework in a timely fashion to effectively capitalize on next year's planned research
   Gaining cooperation from those planning research to include our goals

8. **If the action is tied to another action/project, what is it? Who is sponsor/contact?**
   Needs to be connected to a good fish monitoring program

9. **Approximate cost**
   Immediate work could be around $50,000. Long-term costs would vary depending on how much we can piggyback on other's research.

10. **Location where the action is most applicable**
    Lower Green, Duwamish and Nearshore

11. **Other helpful information.**

"Protection" Study Proposal #1
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Study Proposal –** Inventory of Currently Productive (and Functioning?) Fish Habitat in WRIA 9

2. **Brief Description of Scope of Work** – A component of any successful ecologically based restoration strategy is to protect and maintain watershed habitat forming processes that are functioning properly. This study would include inventory of existing information and field evaluation of habitat in WRIA 9 to identify currently productive (or functioning) fish habitat. An early task would include a workshop of ecologists and habitat experts in WRIA 9 to identify likely target areas (e.g., productive spawning and rearing habitat) and review criteria for evaluating productive habitat. While such habitat is concentrated in the Middle Green subwatershed and nearshore areas of Vashon-Maury Islands, there are other isolated areas of currently productive fish habitat in other parts of WRIA 9. This study will be coordinated with King County's planned effort on identification and field verification of core areas throughout the County. This effort will also be coordinated with the WRIA 9 baseline habitat monitoring efforts.

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts) –** Currently, we do not have a comprehensive inventory of productive fish habitat in WRIA 9, since the reconnaissance report primarily focused on factors of decline. Factors of decline are not addressed per se by this study, but it will focus on areas that have been least affected by the range of factors of decline (such as water quality, hydrology, hydromodifications). This study will provide information that allows us to prioritize areas for preservation and protection to ensure that productive fish habitat and the processes that create such habitat are protected. One work product of this effort will be a map identifying productive (functioning) fish habitat for WRIA 9.

4. **If the project can be phased, describe which elements would be in the first phase. –** The project would primarily consist of a single phase. The follow up phase would focus more on what needs to be done and how best to protect these areas of productive fish habitat (e.g., restoration, regulations, acquisition, conservation easements, etc.)

5. **Proposed Budget and Schedule** - $30-40,000; Project to be carried out Jan.-Dec. 2002

6. **Who is the lead for the study (and partners, if applicable)?** King County is proposed as the lead for this project. The WRIA 9 technical committee would be integrally involved in this project.

"Protection" Study Proposal #2
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Study Proposal** – Identification and characterization of important groundwater and surface water inputs (cool, clean water) to the Middle Green subbasin.

2. **Brief Description of Scope of Work** – Input of cool, clean sources of water to the Middle Green are an important part of habitat conditions that support spawning and rearing of salmonids. The primary sources of such waters are groundwater inputs and cool-water tributaries that are influenced by groundwater or with micro-climates (vegetated, cool air) that keep surface waters cool. Land use, land cover and regional hydro-geologic conditions play an important role in maintaining cool water temperatures. This study would (1) map watershed conditions (e.g., hydro-geologic conditions, vegetation cover) and areas that support cool water source inputs and (2) evaluate how land use/cover changes in the Middle Green affect water temperatures, either locally or regionally. Work would be closely coordinated with the Green Water Quality Assessment effort to monitor and model water temperatures for the Green River basin. There may also be information from King County's normative flow assessment that will be helpful for this study. Relationships between geology, soils and groundwater flow in the vicinity of the historic confluence of the Green and White rivers, and the Deep and Coal creek subbasins, as well as specific cool water tributaries (e.g., Icy Creek, Big Springs Creek) will be the primary focus of the study.

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts) –** The study is expected to identify (and to the extent possible quantify) important cool water inputs to the Middle Green River subbasin. The study will also examine the relationship between land use/cover changes and influences on the quantity and temperatures of cool water inputs. The primary factors of decline addressed include water quality, hydrology, riparian conditions and land use. This study will provide information that allows us to prioritize areas for preservation and protection to ensure that important cool water sources are maintained and possibly enhanced. This would have important benefits for salmonid spawning and rearing habitat in the Middle Green subbasin.

4. **If the project can be phased, describe which elements would be in the first phase. –** The project would primarily consist of a single phase for the Middle Green. A more detailed quantitative analysis of flows could be part of a second phase. Similarly, if there is an interest in expanding this assessment beyond the Middle Green, that could also be a later phase. A final phase would focus more on what needs to be done and how best to protect current sources of cool, clean water in the Middle Green (e.g., vegetation, restoration, regulations, preservation).

5. **Proposed Budget and Schedule** - $70-100,000; Project to be carried out June 2002.- June 2003.

6. **Who is the lead for the study (and partners, if applicable)?** King County is proposed as the lead for this project. The WRIA 9 technical committee and Green WQA would be integrally involved in this project.

"Protection" Study Proposal #3
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Study Proposal –** WRIA 9 Large Woody Debris Assessment.

2. **Brief Description of Scope of Work –** This proposal is an assessment of Large Woody Debris (LWD) in the Green River. The first objective is to determine the potential for future LWD recruitment of standing trees within the Green River riparian zone. The second objective is to assess how quickly the standing trees would eventually get to the river. Large woody debris is an important component of properly functioning instream salmonid habitat. This study would include analyzing existing information and field evaluation. An early task would include a workshop of ecologists and habitat experts in WRIA 9 to identify the scope of this research project.

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts) –** The Habitat Limiting Factors and Reconnaissance Report primarily focused on factors of decline. Currently, we do not have a comprehensive inventory of the potential for LWD recruitment to the Green River from adjacent riparian zones. This study would address the factor of decline related to the lack of wood important for salmon habitat. This research will provide information that could change restoration strategies in Green River riparian zones related to the planting of vegetation and the placement of LWD.

4. **If the project can be phased, describe which elements would be in the first phase. –** NA.

5. **Proposed Budget and Schedule** - $30,000. This research project would be implemented between March and May of 2002.

6. **Who is the lead for the study (and partners, if applicable)?** King County is proposed as the lead for this project. The WRIA 9 technical committee would be integrally involved in this project.

"Protection" Study Proposal #4
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Study Proposal** –Gravel Source Areas in WRIA 9

2. **Brief Description of Scope of Work**
   Identify main sources of gravel to the Green River and major tributaries for the Middle Green. Currently, Howard Hanson Dam (HHD) prevents the downstream transport of coarse sediment, including spawning size gravel. It is necessary to identify the main sources of such coarse sediment to the Green River, both for the purpose of assessing the current conditions of properly functioning habitat and to identify potential quantities and areas for gravel augmentation. One major step towards identifying the main sources of coarse sediment to the Middle Green would be a landslide inventory. A more thorough study would be a sediment budget for the entire Green downstream of HHD, which would characterize areas of sediment supply, transport, and deposition, with estimated transport rates and characterization of sediment sizes. A sediment budget for the Green River downstream of HHD and major tributaries is recommended, to cover all sediment sizes, in the draft Hydrologic Engineering Management Plan (HEMP) under preparation by the Corps of Engineers (COE) as part of the Ecosystem Restoration Study (ERS). Although it is not certain, presumably the COE would either conduct the study or contract for this study to be done.

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts) –** Characterization of sediment supply, transport, and deposition through the mainstem Green and major tributaries.

4. **If the project can be phased, describe which elements would be in the first phase. –** The project could be phased so as to focus first on main gravel sources, which provide spawning size gravels. An inventory of landslides would be the primary way to characterize gravel sources to the Middle Green. Such an inventory is recommended in the HEMP and may already be underway. It is a high priority for completion quickly. A full sediment budget might be considered another phase, since it would make use of the landslide inventory as a component of the overall sediment budget.

5. **Proposed Budget and Schedule** - Since it appears that both the landslide inventory and basin scale sediment budget is to be covered by the COE via ERS, the study budget may be moot for WRIA 9 discussions. The timeframe is not clear for completion, other than that the landslide inventory is high priority. The sediment budget may occur within two years? Further discussion with the COE is recommended to clarify completion of this and other studies recommended in the HEMP and for ERS.

6. **Who is the lead for the study (and partners, if applicable)?** Presumably, the COE will either undertake both landslide inventory and the overall sediment budget, or contract them out as an integral part of the ERS effort.

"Protection" Study Proposal #5
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Study Proposal –** Assessment of Flow Management Alternatives to Maintain and Create Salmon Habitat Development in the Middle Green: Collection of Physical Parameters

2. **Brief Description of Scope of Work** – The purpose of this study is to focus attention on the need to manage river flows to maximize salmon habitat in the middle reach of the Green River and to begin the collection of important physical parameters needed to implement such a flow regime. The middle Green River reach still contains the best spawning and rearing areas for salmon within the accessible watershed even though it has lost 70% of its side channels due to hydromodifications and flow modifications. The remaining side channels can become stranding problems for juvenile salmonids if the flows are not managed properly. Proper management will most likely follow those natural conditions that the species have evolved in concert with. This project includes a side channel study that will document the flows needed to water important side channels.

   River flows are also responsible for many of the important habitat creation (scouring of pools, recruitment of LWD and formation of side channels) and maintenance (removal of fines from spawning areas, keeping pools from filling in) processes within the system.

   Therefore the implementation of a natural flow regime, as noted in the reconnaissance report may be necessary to protect the habitat in this reach. The proposal is to determine the discharge quantities, duration and frequencies necessary to create and maintain specific habitat types in the Middle reach.

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts) –** This study will provide information that will allow us to improve management of mainstem river flows to best maintain and create salmon habitat in the Middle Green. The factors of decline addressed include hydrology and hydromodifications, specifically loss of side channel habitat and migration impediments. The focus will be on protection of the Middle Green and habitat forming processes. Threats to over topping levees, boaters, and scouring of redds will be examined.

4. **If the project can be phased, describe which elements would be in the first phase. –** The first phase would be the side channel study, then secondly the habitat creation/maintenance study.

5. **Proposed Budget and Schedule** – Approximately $50,000.

6. **Who is the lead for the study (and partners, if applicable)?** King County is proposed as the lead for this project. The COE, TPU, and King County Rivers would be partners on the project.

"Protection" Study Proposal #6
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Study Proposal** – Inventory of important feeder bluffs and other beach feeding sources for nearshore areas on Vashon/Maury Island (and unarmored mainland areas?)

2. **Brief Description of Scope of Work** – Nearshore sediments within the central basin are primarily derived from steep glacial till bluffs. Waves and currents transport material downdrift (in the drift cell); under natural conditions, periodic slumping of the bluffs and the resulting redistribution of the material by waves and currents renourish beaches. Shoreline armoring along much of the eastern shoreline of WRIA 9 has greatly reduced the availability of sediment generated from till bluffs (75% of the mainland shoreline and 84% of the Elliott Bay shoreline are armored). On Vashon/Maury Island, 50% of the shoreline is armored. This study seeks to identify areas of active bluff erosion on Vashon/ Maury Island and the mainland. Bluffs would be assessed for toe, slope and bluff conditions. A second phase of the study will seek to perform a sediment budget (quantifying sources and sinks) on key drift cell areas with productive (functioning) habitat. The study will also evaluate what needs to be done to protect these areas from development that would likely lead to additional bulkhead construction. This would include an evaluation of parcels and zoning in vicinity of key feeder bluffs and an assessment of the likelihood of future development.

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts) –** The study is expected to identify important feeder bluffs supporting productive habitat along the nearshore of WRIA 9. An assessment of parcels and zoning in the vicinity of these areas would facilitate evaluation of options for protection of these feeder bluffs. A sediment budget would be used to help quantify how new armoring or removal of existing armoring would affect beach nourishment. The primary factors of decline addressed include shoreline armoring, marine riparian conditions, and land use. This study will provide important information for protection of nearshore processes that support habitat for juvenile salmonids and forage fish.

4. **If the project can be phased, describe which elements would be in the first phase. –** The project would consist of two phases. Phase 1 would focus on identification and assessment of feeder bluffs in WRIA 9 as noted above. The second phase would entail development of sediment budgets for selected feeder bluffs.

5. **Proposed Budget and Schedule** – Phase 1: $25-40,000. Phase 2: $50-100,000, depending on the number and detail of sediment budgets for specific drift cells. Project to be carried out June 2002 - June 2003.

6. **Who is the lead for the study (and partners, if applicable)?** King County and nearshore cities are proposed as the lead for this project. The project could be carried out by a consultant. The WRIA 9 technical committee would also be involved in this project.

Habitat Monitoring Proposal #1
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Research Study Proposal:** Water Quality Sampling Site @ River Mile 21

2. **Brief Description of Scope of Work**
   An additional water quality sampling site would be established on the mainstem Green River, downstream of Mullen Slough, at approximate river mile 21.0. Temperature, dissolved oxygen, TSS, turbidity, and other and other important parameters for salmonids will be collected at the site continuously for a period of five years.

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts)**
   The WRIA 9 Reconnaissance Report, Water Quality chapter, noted the "…paucity of sampling locations for the mainstem of the Green River…" as a data gap. The lack of sites is very apparent for the Lower Green reach. Of the currently operating seven mainstem sampling sites, 5 are located downstream of RM 11.5 (Duwamish) and 2 upstream of RM 33.0 (Middle Green Reach). The Lower Green sub-watershed has been extensively hydromodified, and water quality conditions in the mainstem are suspect. This site will help to establish baseline conditions to assess future water quality trends and progress towards watershed recovery.

4. **If the project can be phased, describe which elements would be in the first phase.**
   Not applicable.

5. **Proposed Budget and Schedule**
   $1,000 per year for 5 years = $5,000

6. **Who is the lead for the study (and partners, if applicable)?**
   Possibly the King County Stream monitoring program as supported by the Green-Duwamish Water Quality Assessment project.

Habitat Monitoring Proposal #2
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Research Study Proposal:** The WRIA 9 Water Budget

2. **Brief Description of Scope of Work:**
The proposed project will gather existing water use information to create a mapped water quantity budget for WRIA 9 on the subbasin scale. Three main tasks will be preformed:
(1) GIS map of active production wells and surface water diversions
(2) Estimate of well production and surface diversion volume on a monthly basis. This information will be sorted by types of land use such as; residential, commercial, industrial, irrigation and undeveloped (forested) areas.
(3) Monthly "managed" water budget estimating the following
   - Evapotranspiration from commercial and residential irrigation
   - Water Supply Production that is exported outside of the basin
   - Water that exits the sub-basin as wastewater
   - Water that exits the sub-basin as sewer infiltration and inflow
   - Water that enters the sub-basin as water supply
   - Water that enters the sub-basin as leakage from water supply

   This type of project was undertaken in WRIA 8 and the effort from WRIA 9 is expected to be very similar. A draft scope of work for the WRIA 8 project is attached.

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts)**
Over-all information about water quantity has been reported as a data gap. This project will set a baseline for existing water quantity contribution of tributaries to the mainstem. The product could highlight areas of concern and lead to conservation plan recommendations for land use.

4. **If the project can be phased, describe which elements would be in the first phase.**
This project will not be phased since it depends on the collection of existing information. It will be more efficient to undertake this project in a single phase. Other projects which could build off this work could be field reconnaissance to discover unreported water diversions in suspect areas.

5. **Proposed Budget and Schedule**
$40,000. Project could be completed within six months of initiation.

6. **Who is the lead for the study (and partners, if applicable)?**
King County hydrologists were active in the mirror WRIA 8 project and could help, although this kind of project for WRIA 9 is not currently budgeted.

Additional Information for Habitat Monitoring Proposal #2
WRIA 9 Water Budget

DRAFT WRIA 8 SCOPE

TASK 1 Map Active Production Wells and Surface Water Diversions

Production well and surface water diversions need to be mapped to show the spatial distribution of withdrawals from water sources throughout the topographic drainage area upstream of the Ballard Locks (WRIA 8). Group A, B and large private non-exempt wells and surface diversions will be mapped for Task 1. In Task 2, the monthly distribution of withdrawal volume of the mapped wells and diversion will be addressed. In Task 3, the consumptive use associated with these withdrawals will be estimated. The final product of all three tasks will be monthly consumptive use within sub-basins of WRIA 8.

Active production wells and surface water diversions in WRIA 8 will be located and mapped using only existing information. The Arc/Info geographic information system (GIS) will be used for this mapping. Group A production wells in WRIA 8 will be mapped based on location coordinates provided by King County. Information on other Group A, B and private non-exempt wells and diversions will be collected from the water rights listings of the Washington Department of Ecology (DOE). Comprehensive water supply plans and utility service area maps will be requested from King County DNR and Seattle Public Utility staff. This information will be used to confirm water rights and Group A well and diversion locations. The King County Health Department will be contacted to confirm location of Group B well and diversion locations. One meeting will be held with King County DNR staff to confirm private non-exempt wells in likely irrigated areas within WRIA 8. Starting in 1972, DOE required driller permits, which include “start cards” containing location and well diameter data. These data will be requested from DOE to screen out small wells from being mapped. All wells, except those shown to have a diameter of less than 4 inches, will be mapped.

The effort required for developing the scope of work of this task is included the task budget.

Deliverable: a GIS coverage of Group A, B and large private non-exempt wells and surface diversions.

TASK 2 Estimate Well Production and Surface Diversion Volume by Sub-Basin

Total water production by sub-basin within WRIA 8 will be estimated on a monthly basis. It is expected that production records exist for some, but not all wells and diversions. In sub-task 2.1, monthly production volumes will be determined from existing records. In sub-task 2.2, monthly production volumes will be estimated using indirect methods for wells and diversions for which no production records exist. Indirect methods will determine a relationship between production and land use within WRIA 8. Production volume is addressed in this task, and consumptive use is addressed in the Task 3. Monthly production volumes will be determined for water year 2000. These volumes will be entered as the monthly production attribute values for each well and diversion included the GIS coverage developed in Task 1. The monthly volume of water produced during water year 2000 from within each WRIA 8 sub-basin will be reported.

Total water production within a sub-basin will be the sum of the water produced for each water use in the sub-basin, minus the amount of imported water to the sub-basin, plus the water exported from the sub-basin. The production of water for these uses can in part include imported water. The non-imported supplies would be produced from local sub-basin ground or surface water. The service area of sub-basin wells and diversions will be delineated based on water utility service areas identified in the comprehensive water supply plans. The volume of exported water that is produced within the sub-basin will be based on the water demands in the service areas outside of the sub-basin.

The effort required for developing the scope of work of this task is included the task budget.

Sub-Task 2.1 Estimating Production Volumes from Existing Data

A search for records of the volume of water diverted from ground and surface water sources, via the surface diversions and production wells mapped in Task 1, will be conducted. Comprehensive water system plans for water utilities within King County and the City of Seattle "Outlook Report" will be reviewed to determine the historical withdrawal amounts and seasonal patterns. Monthly production and diversion data for water year 2000 will be requested from WRIA 8 water purveyors.

Sub-Task 2.2 Estimating Missing Production Data by Sub-Basin

Where production data are not available, existing information will be used to indirectly estimate production on a monthly basis. The water year 2000 production data from Sub-task 2.1 will be used to check production estimates for different types of land use in specific water utility service areas with WRIA 8. Production will be estimated from consumptive uses and efficiency associated with land use. There are two components of the total volume of water produced from a water source: consumed and unconsumed. The consumed component is permanently removed from the source. The unconsumed

component returns to the source, via ground and/or surface water pathways, typically downstream from the point of withdrawal.

For the indirect estimation method, GIS coverages will be developed for sub-basins, water utility service areas, land/water use and production zones. Sub-basins, land use and water and sewer utility service areas will be delineated using existing GIS coverages. It is assumed that King County will provide these coverages. Group A water utility comprehensive water supply plans will be used to confirm the locations of areas of imported water and the distribution of land uses. Water service areas of small and exempt wells and diversions will be lumped together on at most a third order sub-basin resolution. For example, the sub-basin resolution would be no larger than Evans Creek, Bear Creek above Cottage Creek, Little Bear Creek near Woodinville, Rock Creek near Maple Valley, May Creek and other sub-basins of approximately 10 square miles or larger drainage area.

Information from comprehensive water system plans and the recent City of Seattle survey of water supply in King County will be used to estimate monthly production per area of each type of water use. Water uses can be residential, commercial, industrial, irrigation (residential and commercial), and undeveloped (forested and pasture/grass). Water use coverages will be developed by mapping land use into water use categories. Production zone coverages will be developed from the water use coverages and the estimated water demand per type of use.

Water demand per unit area of land use, except for commercial irrigation use, will be estimated from production records within specific water utility service areas. The water produced for municipal and industrial uses is based on the demand per equivalent residential unit (ERU), the number of ERUs per acre, and the efficiency of conveying water from the source to the place of use. The Washington Department of Health, Drinking Water System Design Standards will be used to determine the demand per ERU for this watershed. The selected ERU demands will include lawn watering. The water demand for residential irrigation use will be based on the net consumptive use of grass.

Commercial irrigation use is relatively small based on total acreage within WRIA 8, but it is relatively high on a per acre basis; therefore, it will be included in this analysis. The Washington Irrigation Guide (WIG) includes mean monthly net irrigation requirements (NIR in total inches per acre per month) for several crop types and locations within the county. These net irrigation requirements were determined using a form of the Blanney-Criddle method. Monthly irrigation demand per acre, including residential lawn watering, will be estimated using mean temperature and precipitation, crop type, and calibrated to the NIRs listed for specific locations in the WIG. It is assumed that King County will provide a GIS coverage of monthly precipitation and WRIA 8 topography, mean monthly temperature at Seatac Airport for water year 2000, and a lapse rate to estimate temperature distribution throughout WRIA. The net irrigation requirements will be divided by irrigation efficiency to determine the diversion volume.

Deliverable: For each sub-basin in WRIA 8, the total monthly production for water year 2000, per the following production components, will be delivered:

- Class A
- Class B
- Larger Commercial Irrigation
- Smaller Public and Private.

TASK 3 Determine Monthly Managed Water Budget by Sub-Basin

A managed water budget for each WRIA 8 sub-basin will be developed. This budget will include the bulleted items listed at the end of this task description. Some consumptive use estimates will have already been made during Task 2. The indirect estimate of total diversion volume from water sources within WRIA 8 relies partially on consumptive use and efficiency of the water distribution/irrigation system. Task 2 data represents export of water from sub-basins. Other water exports from a sub-basin include sewer and water supply outflows. Water imports include non-consumed return flow from water withdrawn from sources within a sub-basin, and water supply inflows. The water budgets will equate sub-basin water exports with imported water to validate net consumptive use.

Water consumption will be estimated based on net consumptive use in irrigated areas (e.g. golf courses), and on return of unconsumed flows in other water use areas. Net irrigation consumptive use and total diversion volume will have been evaluated in Task 2. Return flow could be to ground or surface waters or both. In any case, the unconsumed flow is assumed to return within the sub-basin of use. This return flow is from inefficiencies in the irrigation conveyance systems and the irrigation method.

Generally, the combined efficiency is about 50 percent for graded furrow irrigation methods supplied by unlined ditches; therefore, return flows for this method are about equal to net crop consumptive use. Irrigation methods of larger commercial irrigators will be investigated to determine site-specific efficiencies and return flows. Handline sprinkler irrigation methods having an efficiency of 65 percent will be assumed for residential irrigation. The efficiency of residential irrigation will be verified from purveyor production records and net consumptive use estimates.

The percent of water diverted for a residential, commercial and industrial use that is consumed is much less than irrigation use. Only about 10 percent is consumed, leaving 90 percent unconsumed. The return flow from non-irrigation use is largely exported out of the sub-basins via sewer. Residential and commercial areas on septic systems will return unconsumed water to the sub-basin. Generally, areas on septic systems are located outside of sewersheds. Comprehensive sewer plans will be reviewed to determine the portion of sewersheds that remain on septic systems. About 3 percent of precipitation in these areas will infiltrate and inflow to the sewers and export water from the sub-basin.

This consumptive use will be subtracted from the septic return flows from within sewered areas.

It is assumed the King County Wastewater Treatment Division's (WTD) sewershed and conveyance system GIS coverage will be made available from the Facility Information Retrieval System (FIRS), a database maintained by the Wastewater Treatment Division, Facility Inspection Section. It is assumed that the percent sewered area in each sewershed will be obtained from the FIRS.

The effort required for developing the scope of work of this task is included the task budget.

Deliverable: the sub-basins will be prioritized according to net consumption of non-imported water. A table of net consumptive use per month and sub-basin will be produced. The table will break down consumptive use into domestic (in-house), commercial, industrial, and irrigation (commercial and residential). Additionally, the components of the monthly water budgets for 2000 will be tabulated:

- Evapotranspiration from commercial and residential irrigation
- Water Supply Production that is exported outside of the basin
- Water that exits the sub-basin as wastewater
- Water that exits the sub-basin as sewer infiltration and inflow
- Water that enters the sub-basin as water supply
- Water that enters the sub-basin as leakage from water supply

Habitat Monitoring Proposal #3
Development of Study (Research) Proposals
WRIA 9 Near-Term Action Agenda

1. **Name of Research Study Proposal:** Lower Green River Baseline Habitat Mapping

2. **Brief Description of Scope of Work**: This study would establish a baseline for reach-level monitoring of the Lower Green River (RM 32.0 to 11.0). Physical habitat within the current active channel (to 12,000cfs) would be documented using available photographs and field surveys. A GIS basemap will be developed from the information to support long term monitoring.

   Protocols will be established for key habitat parameters and their measurement. These protocols will be reviewed carefully to promote consistency with other efforts in the watershed and their ability to accurately reveal future habitat trends.

   At a minimum the reach-level aquatic habitat-monitoring plan will specify data collection methodologies needed to develop the following information:
   - Habitat unit map
   - Pool area and frequency
   - LWD distribution
   - Coarse sediment distribution
   - Fine sediment distribution
   - Flow-related barriers to upstream fish passage

3. **Expected Results of Study (describe data gaps and factors of decline addressed and benefits of the study to salmon conservation efforts)**
   The WRIA 9 Reconnaissance Report noted lack of a baseline for physical mainstem habitat as an important data gap. This snapshot in time is necessary to gauge future recovery efforts.

4. **If the project can be phased, describe which elements would be in the first phase.**
   This project as described should not be phased, it is important to collect the information quickly during the same time period.

   When additional King County areal photographs and LIDAR imagery becomes available (possibly 2003) the baseline should include a riparian condition element.

   A similar study should be considered for the Duwamish River although protocols and parameters may differ significantly.

   A similar project was undertaken on the Middle Green by the ACOE & Tacoma Public Utilities during 2001. The scope of work for their consultant, R2, was used for producing this proposal. The scope is attached for further information. Although the Habitat Baseline Workgroup is expected to repeat many of the items in the Lower Green, there may be differences once thoroughly reviewed. The workgroup will take all efforts to make the two efforts seamless.

5. **Proposed Budget and Schedule**
   $30,000 for described study,

   $5,000 to add riparian component in 2003

   $15,000 to document Duwamish in similar manner.

6. **Who is the lead for the study (and partners, if applicable)?**
   Possibly consultant, King County GIS staff, partner could be ACOE ERP

Additional Information for Habitat Monitoring
Proposal #3
Lower Green Baseline Habitat Monitoring

ENCLOSURE NO. 1

CENWS-PM-PL-ER 23 July 2001

STATEMENT OF WORK
Baseline Habitat Monitoring of the
Middle Green River, Washington

Contract No. DACW57-00-D-0003, Delivery Order EC-07-NWS

1.0 Purpose. This Statement of Work (SOW) directs R2 Resource Consultants to conduct baseline monitoring of instream habitat within the middle Green River, between river miles 32 to 60, during low flow conditions (mid-summer 2001). This habitat monitoring is necessary to document baseline conditions in the mainstem Green River prior to initiating major restoration projects as part of the Howard Hanson Dam Additional Water Storage Project (AWSP) and the Green-Duwamish Ecosystem Restoration Project. This monitoring is funded by the AWSP.

2.0 Background and Introduction. As part of the Additional Water Storage Project (AWSP), the U.S. Army Corps of Engineers (USACE) and Tacoma Public Utilities will fund long-term monitoring of habitat conditions within the 12,000 cfs floodplain of the Middle Green River downstream of Howard Hanson Dam (RM 64.5). The purpose of long-term monitoring in the middle Green River is to demonstrate the effects of proposed conservation measures at re-establishing natural processes and conditions. The proposed monitoring program consists of baseline monitoring to establish a reference state from which changes resulting from programmatic or site-specific mitigation programs may be measured, followed by repeated surveys to identify trends in habitat conditions that occur as a result of those programs. Monitoring will be conducted at two levels of intensity: reach-scale monitoring intended to document changes in overall habitat conditions within the Green River basin through time; and site specific monitoring that will be used to evaluate the effectiveness of various types of habitat restoration projects.

Baseline monitoring activities must be completed before mitigation/restoration activities are initiated. Baseline habitat surveys and subsequent monitoring efforts should be conducted at flow conditions equivalent to low summer flows during an average year. Although flows of this magnitude may occur during the winter months, stale periods of low flow of the duration required to complete monitoring activities regularly occur only during the summer months. Since construction of restoration projects may begin in 2002, baseline monitoring should be initiated in 2001.

Baseline monitoring will document current habitat conditions using a standardized methodology and will provide a reference point from which changes or trends in aquatic habitat conditions can be demonstrated. The following scope includes activities proposed in support of these efforts, including: 1) development of a study plan; 2) conducting field surveys of baseline habitat conditions in the mainstem Green River; and 3) basic data analyses and mapping to summarize survey results. Side channel habitats in the Middle

Green River were surveyed by R2, Seattle District and the City of Tacoma to establish habitat areas effected during refill of Howard Hanson Dam under baseline and future planned conditions (USACE 1998, Appendix F Part 1). In 1998, 1999 and 2000, under City of Tacoma funding and Planning Assistance to the States cost-shared funding, Seattle District and the City of Tacoma, R2 Resource Consultants monitored habitat use and movement of juvenile salmonids in lateral stream habitats of the Middle Green River (RM 34-46) during water storage and release operations from Howard Hanson Dam (Hilgert and Jeans 1999 and Jeans and Hilgert 2000). Study results will be used to provide baseline information on juvenile salmon and steelhead habitat use of side channels in the middle Green River and to develop dam and reservoir operations that could minimize impacts of water conservation storage under existing and future planned conditions. Surveys in 2001 will constitute the fourth and final year of baseline monitoring prior to the initiation of the AWSP in 2005.

3.0 Specific Requirements. R2 is requested to:

Task 1. Develop Study Plan

Habitat survey protocols currently used by government agencies, tribes and other entities will be reviewed to determine the most appropriate approach for conducting surveys in the mainstem Green River. Organizations that have recently completed or are planning habitat restoration projects in the middle Green River will be contacted to determine what monitoring programs are currently underway and what key monitoring parameters, definitions, data standards, and basemap each program uses. Based on the review and interviews, a draft list of recommended key parameters, definitions, and measurement standards for reach-scale monitoring will be developed.

A workshop designed to organize and facilitate a discussion of mainstem habitat monitoring standards and guidelines for the Green River will be organized to support development of a reach-level study plan. The workshop will focus on reach-level physical habitat monitoring in the mainstem middle Green River. Participants will include federal, state and county resource management agencies, tribes, non-government organizations and other parties currently working on or planning habitat restoration projects in the middle Green River basin. The goal of the workshop is to reach an agreement on basic monitoring approaches, key parameters and data collection standards that will encourage consistency and comparability between monitoring programs conducted by the various entities. Following the workshop, a record of the meeting will be prepared and distributed to participants and interested parties.

Based on the literature review and workshop outcome, a detailed monitoring plan for baseline reach-scale habitat monitoring will be developed for implementation in 2001 as part of the AWSP. The monitoring plan will include recommended measurement standards for all key monitoring parameters identified at the workshop, as well as procedures for collecting supplemental information specific to AWSP project

components. At a minimum the reach-level aquatic habitat-monitoring plan will specify data collection methodologies needed to develop the following information:

- Habitat unit map
- Pool area and frequency
- LWD distribution
- Coarse sediment distribution
- Fine sediment distribution
- Flow-related barriers to upstream fish passage

Task 2. Conduct Mainstem Baseline Habitat Monitoring Surveys.

For the purpose of developing this scope of work, the study area was assumed to consist of the mainstem Green River downstream of Howard Hanson Dam (RM 64.5) to the Highway 18 bridge (RM 32), and will not extend into the lower Green River below RM 32. Downstream of Howard Hanson Dam, the river flows through a moderately confined mountain valley (RM 64.5 to RM 57) into a steep, tightly confined gorge (RM 45 to RM 57) and then into a wide, unconfined alluvial valley. Historically, the alluvial valley segment of the Green River continued downstream past the former confluence with the White River around RM 32. The reach downstream of RM 32 is currently a winding channel constricted by levees on both sides.

The study area will be stratified into six reaches. Reach boundaries were developed based on channel type characteristics and hydrology. Reaches will be delineated as follows:

1) RM 32 (Auburn Narrows) to RM 38 (Loans Levee)
2) RM 38 (Loans Levee) to RM 40 (Newaukum Creek)
3) RM 40 (Newaukum Creek) to RM 45 (Flaming Geyser Park)
4) RM 45 (Flaming Geyser Park) to RM 57 (Kanasket State Park)
5) RM 57 (Kanasket State Park) to RM 61.5 (Tacoma Headworks)
6) RM 61.5 (Tacoma Headworks) to RM 64.5 (Howard Hanson Dam)

Ultimately, a Geographical Information System (GIS) basemap should be developed to support long-term monitoring in the Middle Green River. King County is currently in the process of contracting countywide (including the Middle Green River) aerial photo and RADAR surveys. These surveys are expected to result in production of 1:12,000 scale digital orthophoto quadrangle maps and development of a surface model with ground contour intervals of approximately two feet. The anticipated completion date of this work is 2003.

In the interim, recent low-level aerial photographs of the Middle Green River will be used as a basemap. Low level photographs flown in 1998 for the USACE in support of the Howard Hanson Dam 35% design report and Green Duwamish Ecosystem Restoration project will be used for habitat mapping. A temporary GIS basemap will be developed for the portion of the river between RM 32 and RM 45 by overlaying floodplain maps dating from 1994 onto the 1998 photos.

Field surveys of baseline habitat conditions in the mainstem Middle Green River will be conducted during summer and fall 2001 when flows in the middle Green River are

approximately 250 to 300 cubic feet per second (cfs). For the purpose of this scope and budget it is anticipated that completion of the mainstem baseline habitat surveys will involve the following activities:

Large woody debris (LWD) distribution. The frequency and distribution of LWD will be assessed by conducting ground surveys of the entire Middle Green River study reach (RM 64.5 to RM 32). Surveys will be conducted by boat (raft or canoe), except for within the Green River gorge where surveys will be conducted by a combination of float and pedestrian techniques dependent on flow and channel conditions. Individual pieces of large woody debris and debris jams (as defined in the workshop) will be tallied by size class. LWD sizes will be occularly estimated, following calibration of surveyor estimates by estimating then measuring a specified number of pieces. The location of all LWD jams will be mapped using a Global Positioning System (GPS) or by marking the location on copies of low-level aerial photographs based on landmarks that are recognizable from both field and photo.

Habitat Mapping. Habitat units (as defined during the workshop) will be mapped by conducting ground-based surveys of the entire Middle Green River study reach (RM 64.5 to RM 2). Surveys will be conducted by boat (raft or canoe), except for within the Green River gorge where surveys will be conducted by a combination of float and pedestrian techniques dependent on flow and channel conditions. The dimensions of all habitat units will be occularly estimated following calibration of surveyor estimates by estimating then measuring a specified number of units.

The location of each pool (as defined during the workshop) will be mapped using GPS (if practicable) or by marking the location on copies of low-level aerial photographs based on landmarks that are recognizable from both field and photo. The length, width, maximum depth and residual depth of each pool will be recorded using standards identified during the workshop. Pool type (after Hawkins et al. 1993) and formative factor will be recorded for each pool.

Photographs, bankfull channel width, wetted width and shade will be recorded at 1000-m intervals. Information on bank composition and riparian community type will be recorded on draft basemaps as the survey progresses downstream.

Coarse Sediment Composition. Wolman pebble counts will be conducted on at least 5 riffles within each reach during field surveys. The distribution of spawning gravels will be characterized using the Timber, Fish, and Wildlife (TFW) transect method in one randomly selected 1000-meter long reach within each channel segment. Segment endpoints will be located using GPS, and permanent reference points will be established at each end to facilitate future re-surveys.

Fine Sediment Distribution. The distribution of fine sediment along channel margins will be evaluated using the TFW transect method in one randomly selected 1000-meter long reach within each channel segment. Segment endpoints will be located using GPS, and permanent reference points will be established at each end to facilitate future re-surveys.

The distribution of fine sediment in pools will be assessed by measuring the v* parameter (Lisle and Hilton 1982). V* will be assessed in five randomly selected pool habitat units from each reach. The pool volume and volume of fine sediment within the pool will be calculated by collected at least 12 pool depth and sediment depth measurements within each pool. The location of each sample pool will be recorded using GPS, and permanent reference points will be established at each site to facilitate future re-surveys.

Barriers to Upstream Fish Passage. There are currently no known physical barriers to fish passage within the middle Green River, and several species of anadromous salmonids routinely reach the Tacoma Headworks at RM 61.5, indicating that there are no permanent fish passage barriers. However, flow-related passage concerns have been identified as a concern in the Middle Green River (WRIA 9 FODS 2000). Shallow riffles representing potential barriers to upstream fish passage within the mainstem will be identified during habitat mapping. The location of riffles where no flow path with a depth greater than 1 foot exists will be recorded using GPS or by marking the location on copies of low-level aerial photographs based on landmarks that are recognizable from both field and photo. The length of the riffle unit across which the water depth is less than 1 foot will be measured using a surveyors tape. The gradient of shallow riffle sections will be estimated using a handlevel or clinometer and a survey rod.

Cascade habitat units representing potential impediments to upstream passage within the Green River gorge will also be identified and mapped. The location of cascade units with a gradient greater than 12 percent over a distance of 100 feet or more will be recorded using GPS or by marking the location on copies of low-level aerial photographs based on landmarks that are recognizable from both field and photo. The length of the cascade unit will be measured using a suveyors tape. The gradient of steep cascade units will be estimated using a handlevel or clinometer and a survey rod. Photographs will be taken of all areas where potential passage concerns are identified.

Task 3 Data summary

Reach endpoints, subsample segments, pool locations and LWD jam locations will be digitized to produce a GIS habitat overlay. Habitat data will be entered into and EXCEL spreadsheet. Data will be summarized by reach in tabular format.

Habitat Monitoring Proposal #4

Development of Research Study Proposals (Doable Actions)

WRIA 9 Near-Term Action Agenda

1. **Name of Research Study Proposal:** Nearshore Baseline Inventory Mapping

2. **Brief Description of Scope of Work**
   Map salmonid habitat in tidal areas of WRIA 9 (includes Duwamish River) that could be used for establishing baseline conditions; map salmonid habitat conditions and stressors, identify properly functioning habitat, and possibly identify and prioritize restoration opportunities in littoral areas of the estuary and nearshore. Tasks include:
   a) Gather data using Reconnaissance Assessment Report, Ecology shoreline photos, DNR Shorezone data base.
   b) Conduct field surveys to assess nearshore habitat in the WRIA.
   c) Define, identify, and map habitat quality.
   d) Map important habitat (eelgrass, tidal channels, good riparian conditions, saltmarsh, feeder bluffs, sources of LWD, etc.) and properly functioning habitat.
   e) Map important habitat stressors (bulkheading, contamination, overwater structures, etc.)

3. **Expected Results of Study (describe data gaps addressed and benefits of the study to the overall salmon conservation planning process)**

   Baseline information was noted as a data gap for the nearshore of WRIA 9 and Vashon Island. This study could help to set a benchmark by which to judge future recovery.

4. **If the project can be phased, describe which elements would be in the first phase.**
   This project should be done all as one phase.

5. **Proposed Budget and Schedule**
   Approximately $25,000 consultant cost. Assumes GIS/air photo interpretation plus some field verification. Assumes lead agency will provide GIS base map and GIS mapping support.

6. **Who is the lead for the study (and partners, if applicable)?**
   King County, Seattle, or WDFW could lead the study. Partners could include People for Puget Sound or other nearshore groups.